

Pipe Design Worksheet

Project # /Name: Estates at Bull Meadow

Calculated By: BRM

Checked By: PJM

Date: 6/10/2016

Date: 6/10/2016

Revised: 2/22/2017

EXHIBIT 46
Received 2/22/17

n= 0.013 RCP Pipe

Culvert	Q	Qsum	Length	Slope	Dia.	Full-Flow Velocity ¹	Full-Flow Capacity ²	
(ID)	(cfs)	(cfs)	(ft.)	(ft./ft.)	(in.)	(fps)	(cfs)	
Detention Basin								
CB 9 to DMH 11	1.00		30	0.01	12	4.55	3.57	O.K
CB 10 to DMH 11	1.00		14.6	0.01	12	4.55	3.57	O.K
DMH 11 to DMH 10		2.00	192.4	0.04	12	9.10	7.14	O.K
DMH 10 to DMH 9	2.00		75.4	0.04	12	9.10	7.14	O.K
CB 8 to DMH 9	0.70		14.2	0.01	12	4.55	3.57	O.K
DCB 7 to DMH 9	2.30		7.1	0.01	12	4.55	3.57	O.K
DMH 9 to DMH 8		5.00	89	0.01	18	5.96	10.53	O.K
DMH 8 to FES 5	5.00		161	0.01	18	5.96	10.53	O.K
DCB 6 to DMH 7	3.20		14.6	0.01	12	4.55	3.57	O.K
DCB 5 to DMH 7	2.20		7.1	0.01	12	4.55	3.57	O.K
DMH 7 to DMH 7A		5.40	57	0.005	18	4.21	7.45	O.K
DMH 7A to FES 4	5.40		60	0.01	18	5.96	10.53	O.K
CB 4 to DMH 6	0.70		12.6	0.01	12	4.55	3.57	O.K
CB 3 to DMH 6	2.20		15.8	0.01	12	4.55	3.57	O.K
DMH 6 to DMH 5		2.90	168.2	0.005	18	4.21	7.45	O.K
DMH 5 to DMH 4	2.90		72.7	0.005	18	4.21	7.45	O.K
DMH 4 to DMH 3	2.90		124.4	0.005	18	4.21	7.45	O.K
CB 2 to DMH 3	1.30		14.1	0.005	12	3.22	2.53	O.K
CB 1 to DMH 3	1.30		3.5	0.005	12	3.22	2.53	O.K
DMH 3 to DMH 2		5.50	136.9	0.005	18	4.21	7.45	O.K
DMH 2 to DMH 1	5.50		143.3	0.005	18	4.21	7.45	O.K
DMH 1 to FES 1	5.50		22.5	0.005	18	4.21	7.45	O.K
CB 12 to DMH 12A	0.50		7	0.01	12	4.55	3.57	O.K
CB 11 to DMH 12A	0.80		7	0.01	12	4.55	3.57	O.K
DMH 12 to FES 3	1.30		34.5	0.01	12	4.55	3.57	O.K
DMH 12A to DMH 12		1.30	25.4	0.01	12	4.55	3.57	O.K
CB 14 to DMH 13A	0.80		7	0.01	12	4.55	3.57	O.K
CB 13 to DMH 13A	0.80		7	0.01	12	4.55	3.57	O.K
DMH 13 to FES 2	1.60		62	0.01	12	4.55	3.57	O.K
DMH 13A to DMH 13		1.60	5.6	0.01	13	4.80	4.42	O.K
DMH 14 to DMH 15**	15.42		40.9	0.04	18	11.92	21.07	O.K
DMH 15 to DMH 16**	15.42		105.1	0.04	18	11.92	21.07	O.K
DMH 16 to DMH 16A**	15.42		205.8	0.029	18	10.15	17.94	O.K
DMH 16A to DMH 17**	15.42		104.3	0.04	18	11.92	21.07	O.K
DMH 17 to DMH 18**	15.42		190.9	0.01	21	6.61	15.89	O.K
DMH 18 to HW 2**	15.42		35.2	0.01	21	6.61	15.89	O.K
2'x3' Culvert	See Drainage Analysis							
5'x10' Culvert	See Drainage Analysis							

* Flows from the 100-year storm event were utilized from HydroCAD to size the headwall outlets.

$$^1 V = 1.49/n \times R^{2/3} \times S^{1/2}$$

$$^2 Q = VA$$

***Flows from the 100-year storm event from the "North Grafton Estates II" Stormwater Management Analysis, Dated March 21, 2002 were used as design flows.*

$$^1 V = 1.49/n \times R^{2/3} \times S^{1/2}$$

$$^2 Q = VA$$

Waiver Request Form:

Estates at Bull Meadow – Definitive Subdivision

Submitted 6/10/2016 – Revised 2/22/2017

We request the following waivers from the requirements of the Rules and Regulations Governing the Subdivision of Land in Grafton, Massachusetts:

1. From 5.4.2.2 - At least four feet (4') of cover will be required over drain pipes. Where special conditions of topography and/or hydrology are deemed to justify the Board's approval of pipe with less than four feet (4') of cover, the Board may require other materials or methods of construction to meet such conditions.

The minimum cover over the drainage trunk line on Carriage House Lane from DMH 6 to proposed Infiltration Basin 1 is 2.5'. This waiver is requested in order to avoid a submerged inlet to the proposed infiltration basin and maintain adequate separation from the bottom of basin to the high groundwater elevation.

The minimum cover over the drainage trunk line from DMH 14 to DMH 18 is also 2.5'. This drainage trunk line is a cross country drain that is required to convey an 18" discharge from the North Grafton Estates II Subdivision to the receiving wetland on the Estates at Bull Meadow Subdivision. The trunk line is located in the middle of a woodland area that will never be driven over or exposed to mechanical loads therefore 4 feet of cover is not required to protect the pipe.

2. From 3.3.3.21(a) – Typical roadway cross-sections of each street. See Schedules A&B Typical Roadway Cross Section.

The variance requested is from the Standard Cross Section for a Minor Street B. This standard cross section is being utilized in the design of the Definitive Subdivision per the conditions of the Planning Board's Preliminary Plan Approval. There are two locations where we are requesting relief from the 12' shoulder dimension of this detail.

- The first location is within the access easement at the end of the cul-de-sac on Appaloosa Drive between STA 14+81.56 to STA 16+76.06. The access easement is of adequate width to allow for the standard cross section however there is no grading easement to allow the proposed shoulder elevations to return to existing grades. The 12 foot shoulder on the 10 Appaloosa Drive side of the proposed subdivision roadway is required to deviate from the Standard Cross Section for a Minor Street B in order to meet existing grade. The applicant owns 11 Appaloosa Drive therefore we can maintain the Standard Cross Section with a sidewalk on

that side of the proposed roadway without requiring an additional grading easement.

- The second location is along the elevated wetland crossing from STA 12+49.47 to STA 14+44.18. Relief is requested from the Standard Cross Section in order to minimize the wetland impact while maintaining a safe width, including a 5.5 foot shoulder (face of curb to face of wall) on the south side of the road and a 10.5 foot shoulder (face of curb to face of wall) including a 4 foot sidewalk on the north side of the road. This layout would place the retaining wall within the Right of Way.
3. From 4.1.2.1(b) - The proposed streets in the subdivision shall be so designed as to minimize cut and fill. Cuts or fills greater than four (4) feet are considered significant and, in addition to the specific provisions of these Regulations, additional design and/or construction provisions may be required by the Board. Proposed grades within the right-of-way, including any cul-de-sac, shall not be more than six feet (6') above or below existing grade unless specifically authorized by the Planning Board in unusual topographic circumstances.

The proposed grades at the elevated wetland crossing will be a maximum of 12 feet above grade at the high point in the roadway at STA 13+81.02. This elevation is unavoidable due to a bordering vegetated wetland being located at the end of the access easement from Appaloosa Drive.

4. From 4.1.5.3 - Where changes in grade exceed one-half of one percent (0.5%), vertical curves will be provided. The minimum length (k value) of vertical curves shall be designed in accordance with the following: Minor Streets – Crest $k=28$, Sag $k=35$.

The crest curve at STA 13+81 has been revised to meet the minimum k value of 7 which corresponds to the AASHTO design k value for a 20 MPH roadway. See attached letter from the Transportation Consultant, Green International Affiliates, Inc. (GIA) for their response documenting that the design k values used in the design are acceptable for a residential roadway.

5. From 4.9.1- Sidewalks, grass plots and trees shall be provided for the full length of each street. Sidewalks shall be provided on one side (preferably north, west sides) of Minor Streets and both sides of Major Streets. Sidewalks shall be at least four (4) feet wide, shall conform to all Access codes, and shall be located as shown on the plans and profiles required by these Regulations.

Concrete sidewalks are proposed within the development however they are not proposed across driveways. This design is consistent with the existing neighborhood in addition to providing a safer driveway design for snow plowing and maintenance considerations.

We request the following waiver from the requirements of the Rules and Regulations for the Administration of the Town of Grafton Local Wetlands Bylaw:

6. From 5.B.5(h)(3)- The basin shall be fenced and securely gated to deter unauthorized access. Fencing shall be placed so as not to interfere with the maintenance of the basin.

Conservation Commission has asked us to request a waiver as they do not want the proposed fences around the basins.

We request the following waiver from the requirements of the Town of Grafton Conservation Commission Regulations Governing Stormwater Management:

7. From 6.B.3(d)- Water velocities in pipes and gutters shall be between two (2) and ten (10) feet per second, not more than five (5) feet per second on paved surfaces, and not more than four (4) feet per second in vegetative areas.

The design of the proposed cross country drain line between DMH 14 and DMH 17 has been revised to reduce the water velocity from a maximum of 18.08 feet per second to a maximum of 11.92 feet per second. This proposed maximum water velocity falls within the velocity range of standard good engineering practice of two (2) and twelve (12) feet per second.